Heat and Mass Transfer Technological Center (CTTC)

Universitat Politècnica de Catalunya BARCELONA TECH (UPC)
CTTC director: Prof. Assensi Oliva
CTTC research co-director: Prof. Carlos D. Pérez-Segarra
CTTC promoter: Prof. Joaquim Rigola
CTTC personnel: 50 persons full time (30 Ph. D. students)
More than 100 international journal papers in last 10 years
More than 60 research projects with companies, and within national and EU frameworks in last 10 years

A renowned worldwide research group in Solar Energy, Thermal Systems and Computational Fluid Dynamics and Heat Transfer

Mathematical formulation, numerical resolution and experimental validation of heat and mass transfer phenomena.

- Refrigeration (vapour compression cycles, absorption refrigerating systems, compressors, expansion devices, etc.).
- HVAC (ventilation, diffusion of contaminants in buildings,...).
- Active and passive solar systems (solar collectors using transparent insulation materials, building facades with transparent layers and ventilation, etc.).
- Concentrated Solar Plants (CSP) (solar tower, storage tanks, etc.)
- Wind Energy (blade design, thermal nacelle, wind farms, etc.)
- Heat exchangers (single – phase and two – phase heat exchangers, combustion heaters,...).
- Heat storage by liquids and using phase change materials.
- Engine cooling and air conditioning in the automobile and the aeronautical fields.
- Aerodynamics, etc..

Thermal and fluid dynamic optimization of thermal systems and equipments. Application of the acquired know-how from the basic studies

- Natural and forced convection
- Turbulence simulation (RANS, LES, DNS)
- Combustion
- Two-phase flow (VOF, two fluid models)
- Solid-liquid phase change (PCM materials)
- Radiation (surface and participating media)
- Porous media
- Computational Fluid Dynamics and Heat Transfer (CFD&HT)
- Compressible effect and noise evaluation
- Computational Structure Dynamics (CSD) and Fluid Structure Interaction (FSI)
- Aerodynamics
- High performance computing: Numerical algorithms and solvers, parallel computing, etc.
Computational Fluid Dynamics and Heat Transfer (CFD&HT): TermoFluids code

- 3D parallel unstructured code
- DNS, RANS and LES turbulence models
- Dynamic mesh methods for CSD and FSI
- Radiations, combustion
- Multi phase phenomena
- Multi physics modelling

Object Oriented tools for thermal systems and equipments: NEST code

- Modular object-oriented buildings (rooms, walls, HAM+VOC; IAQ, active virtual control): NEST buildings
- Multiscale approach wind energy applications: NEST wind farms
- Multiscale approach solar tower receivers: NEST CSP
- Thermal Energy Storage Tanks: NEST STES & LTES
- Vapor Compression, absorption and adsorption refrigeration and systems NEST cycle
- Condensers, evaporators and radiators: NEST heat exchangers
- Hermetic reciprocating compressors: NEST compressors
CTTC High Performance Cluster (HPC – JFF)

- Beowulf HPC cluster.
- Infiniband DDR 4X network interconnection between nodes with latencies of 2.25 microseconds with a 20Gbits/s bandwidth.
- The system of files allow unified capacities of several Petabytes highly scalable.
- 128 nodes, each node has two Quad-core CPUs, total of 1024 processing cores.
- 40 nodes, each node has 32 Cores, total of 1280 processing cores.

CTTC Experimental facilities

- Vapor compression refrigerating systems (R600a, R134a, CO₂, etc.)
- Calorimeter compressor test
- Fin and tube heat exchangers test loop
- Climate chamber
- Motor bench
- Storage tanks
- Flat plate solar collectors
- Different types of ventilated façades
- Bioclimatic building
Top 10 CTTC-UPC research projects within last 5 years

1. Research Project **ENE2014-60577-R**: MEC (Spanish Government); Funding: 100,000 Euros; Title: Development of high-performance parallel codes and algorithms for the improvement of the efficiency applied to wind-energy, solar thermal and building; Period: 2015 – 2017.


5. Research project, ref. **FP7- EeB.NMP.2013-3**, E01199; Title: RESEEPE Retrofitting solutions and services for the enhancement of energy efficiency in public edification; Funding: 368,871 Euros; Period 2013-2015.

6. Research project Q-00023; Company: **EIT-KIC InnoEnergy project**; Title: Thermal storage for concentrating solar power plants; Funding: 650,000 Euros; Period: 2011-2014.

7. Research project C-08632; Company: **Anortec, S.L.**; Title: Research and development for the aerodynamic design of the blades of aerogenerators; Period: 2011-2012.

8. Research project Q-00011; Company: **EIT-KIC InnoEnergy project**; Title: Energy storage as necessary part of energy balanced building and districts; Period: 2011-2014.

9. Research Project E01053, ref. 218849, **ISP-1; European Commission**, Directorate-General XII; Companies: Snecma, Astrium, AVIO, Mikroma, Alcimed, Bonatre; Funding 206,250 Euros; Title: In Space Propulsion 1; Period: 2009-2012.

10. Research Project, ref. C07564; Company: **Abengoa Solar New Technologies**; Title: Project “ConSOLI+Da” Consorcio Solar de Investigación y Desarrollo; Subject: Vapour receivers for solar tower power plants; Funding 500,000 Euros; Period: 2008-2011.
Most relevant CTTC-UPC advanced computing projects within last 5 years

1. PRACE Project ref. 2016153612 PRACE 14th Call. Direct Numerical Simulation of Bubbly Flows with Interfacial Heat and Mass Transfer. 18 milions of CPU hours (2017-2018)

2. PRACE Project ref. 2015133120 SANDGRAIN. Understanding the effects of wall-surface roughness on the flow past circular cylinders. 31 milions of CPU hours (2016-2017)


10. PRACE Project ref. 2012071290 DRAGON - Understanding the DRAG crisis: ON the flow past a circular cylinder from critical to trans-critical Reynolds numbers. 23 milions of CPU hours (2013-2014)
TF’s business overview

HT&CFD – HPC – Multi-scale – Multi-physics – High Efficiency Systems

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